



## Emotional valence, sense of agency and responsibility: A study using intentional binding



J.F. Christensen<sup>a,\*</sup>, M. Yoshie<sup>b,c</sup>, S. Di Costa<sup>a</sup>, P. Haggard<sup>a</sup>

<sup>a</sup> Institute of Cognitive Neuroscience, University College London (UCL), United Kingdom

<sup>b</sup> Human Informatics Research Institute, National Institute of Advanced Industrial Science and Technology (AIST), Japan

<sup>c</sup> Automotive Human Factors Research Center, AIST, Japan

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### ABSTRACT

We investigated how the emotional valence of an action outcome influences the experience of control, in an intentional binding experiment. Voluntary actions were followed by emotionally positive or negative human vocalisations, or by neutral tones. We used mental chronometry to measure a retrospective component of sense of agency (SoA), triggered by the occurrence of the action outcome, and a prospective component, driven by the expectation that the outcome will occur. Positive outcomes enhanced the retrospective component of SoA, but only when both occurrence and the valence of the outcome were unexpected. When the valence of outcomes was blocked – and therefore predictable – we found a prospective component of SoA when neutral tones were expected but did not actually occur. This prospective binding was absent, and reversed, for positive and negative expected outcomes. Emotional expectation counteracts the prospective component of SoA, suggesting a distancing effect.

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## 1. Introduction

Sense of agency is the experience of control over our own voluntary actions, and, through them, events in the outside world. Sense of agency is a core feature of normal mental life, at least in healthy adult humans, and a prerequisite of a well-functioning society. For example, legal systems assume that we will always *know* whether we have caused an event or not, because we *experience* our actions, and, at least partly, understand their consequences, at the time that we make them. Other things being equal, a defendant who has a sense of agency regarding the appropriate action is expected to plead *guilty*, and one who does not is expected to plead *not guilty* to the appropriate charge.

If the sense of agency perfectly tracked the facts of agency, there would never be doubt about who caused a particular outcome, and was thereby responsible. However, the sense of agency is limited for several reasons. First, sense of agency does not perfectly track the objective facts of agency. For example, a person may make an action and cause an outcome, but not realise they have done so. One reason for this gap between objective and subjective agency is limited cognitive capacity: people clearly cannot foresee all the consequences of their own actions. Here we focus on a different limitation, namely the strong biasing effect of affective valence on sense of agency. These effects are often considered under the label self-serving bias (Bandura, 1982; Bradley, 1978; Heider, 1958). People attribute positive actions and outcomes to

\* Corresponding author at: Institute of Cognitive Neuroscience, University College London (UCL), Alexandra House, 17 Queen Square, London WC1N 3AR, United Kingdom.

E-mail address: [j.christensen@ucl.ac.uk](mailto:j.christensen@ucl.ac.uk) (J.F. Christensen).

themselves, while distancing themselves from bad actions and outcomes, notably by attributing them to others. Previous studies of such biases have used a framework of attribution judgement to consider these biases, often within the social context of praise and blame.

However, the relation between such social judgements of agency, and the primary experience of agency, remains unclear. This issue is important, since people often know from direct experience that they are responsible for an outcome, yet then explicitly attribute responsibility to another (e.g., “passing the buck”, “only obeying orders”; Miller, 1947, 2009). Such psychological phenomena imply a basic, pre-attributional experience of agency, which is sensitive to valence. However, this experience, and its valence-sensitivity have proved difficult to measure scientifically, resulting in a knowledge gap in the literature on psychology of agency and responsibility.

Here we have used action binding (Haggard, Clark, & Kalogeras, 2002; Moore & Obhi, 2012) as an implicit measure of sense of agency. The perceived time of a voluntary self-generated action is shifted towards the action’s outcome, as compared to a condition where the action is not followed by a sensory outcome. There is also a corresponding shift in the perceived time of the outcome back towards the action that caused it.

Yoshie and Haggard (2013) compared intentional binding for actions which predictably had either positive, negative or neutral sounds as their outcomes. Binding was reduced for negative action outcomes as compared to positive ones. This implies a stronger sense of agency over positive compared to negative events, consistent with the concept of a self-serving bias (Bandura, 1984), and/or a distancing from negative outcomes as a form of reappraisal mechanism (Ochsner, Bunge, Gross, & Gabrieli, 2002). Takahata et al. (2012) obtained similar results in the context of a gambling task. Different tones were first associated with either positive or negative outcomes of one’s own action (gains or losses). Subsequent intentional binding measures showed less binding, implying reduced sense of agency, for tones that had previously been associated with losses, compared to rewards.

The experience of agency over an outcome could be based on predicting the outcome (e.g., I feel in control of my bicycle, because I predict that turning the handlebars will change my direction), or on inferring retrospectively the consequences of my own actions (e.g., I win money because I gambled. Although the stakes were 50–50 my winning makes me retrospectively attribute the winning to my skill in choosing) (Moore & Haggard, 2008). It remains unclear whether valence effects on sense of agency are primarily prospective, or primarily retrospective. In previous studies (Yoshie & Haggard, 2013), the valence of an action was entirely predictable, since participants generated positive, negative or neutral outcome sounds in separate blocks. In this situation, both prospective and retrospective components can contribute to sense of agency, but cannot be specifically disentangled. In Takahata et al. (2012), the valence of the outcome was randomised, and therefore unpredictable. In their results, outcome valence influenced sense of agency retrospectively. However, it remains unclear whether valence can also influence prospective sense of agency.

This issue has important implications. Purely retrospective valence effects imply a failure to feel responsible for actions with negative outcomes. This would be highly adaptive in ensuring well-being, but would have catastrophic implications for society. A well-functioning society, at least one similar to our own, presupposes that individuals avoid making actions with negative outcomes, even when these actions are superficially tempting. Presumably, individuals learn from previous experience the relation between actions and negative outcomes, and then use these experiences to prospectively guide future agency. A genuine, valence-sensitive experience of agency at the time of an action therefore plays an important role in minimising future harmful actions.

Moore and Haggard (2008) proposed an experimental design to distinguish the influence of prospective and retrospective mechanisms on sense of agency, based on manipulating outcome probabilities. The probability of producing an outcome is set to 50% in one block of the experiment, and to 75% in another (Moore & Haggard, 2008; Voss et al., 2010). An estimate of the retrospective component of sense of agency is obtained by comparing the binding of action towards tones on those trials in the 50% block where a tone does occur, with those trials where it does not. An estimate of the prospective component is obtained by comparing the binding of actions towards tones on trials where tones do not in fact occur, but are more likely (i.e., 75% block), compared to less likely (i.e., 50% block). Prediction should clearly be stronger in the 75% block than in the 50% block, although it is not total in the former, nor absent in the latter – thus the design affords a partial estimate of the prospective component, rather than a perfect measure. Nevertheless, comparing estimates for prospective or retrospective components between groups (Voss et al., 2010), or between different conditions may clarify whether a particular factor influences prospective or reconstructive components of sense of agency.

We investigated how the valence of an action outcome would influence the retrospective and prospective components of sense of agency. The probability of producing an action *outcome* was either highly likely (75%) or moderately likely (50%), and retrospective and prospective components of action binding were calculated. In Group 1, outcome *valence* was *unpredictable*, because positive, negative and neutral sounds were randomised. This means that for this group, the valence of the outcome, if it occurred, was experienced anew on each trial. This allowed us to assess whether the outcome valence of an action modulates sense of agency *retrospectively*. In Group 2, the same outcome sounds were blocked, so that the *valence* of the sound was always *predictable*, though its *occurrence* could be more or less predictable, as before (50% or 75%). With this we sought to establish whether the prospective component of sense of agency would emerge if the valence of the outcome, as well as its occurrence, were predictable.

Our general research question was whether outcome *valence* influences the prospective or the retrospective part of sense of agency, and whether this influence depended on *valence* itself being predictable.

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